Written Examination Special Relativity F8066

Academic Year 2002–2003: 2 September 2003, 2.30-4.30 PM

Please read the following INSTRUCTIONS

A. Answer at most TWO questions. You may answer in english or in italian. A pass is obtained for one complete answer, and full marks for two complete answers.

B. You may not use notes or textbooks, but the course notes are available for consultation at the front desk.

C. On your answer paper, please rewrite and sign the pledge "I swear on my honour that I have neither given nor received help during this examination."

---

1. Two photons move along the positive x–axis in an inertial frame K, with a constant distance L between them. Another inertial frame K' moves with constant velocity v along the x–axis of K. What is the distance between the photons in K' ?
(**Hint:** consider the equation of motion of each photon.)
Ans: $\gamma L(1 + v/c)$

2. How many instantaneous speed increments of 0.5 c does a particle need in order to accelerate from rest to 0.8 c ? What is its speed after four such increments ?
Ans: 2 increments, $40/41c$

3. A particle of rest mass m decays from rest into a particle of rest mass $m' < m$ and a photon. What are their energies, in terms of m and m' ?
Ans: $E = \frac{(m^2+m'^2)c^2}{2m}, \hbar\nu = \frac{(m^2-m'^2)c^2}{2m}$

4. Prove that

i) any non–zero four–vector orthogonal to a timelike four–vector must be spacelike (e.g. u^μ and a^μ);

ii) the sum of two timelike four–vectors, both pointing into the past, or both into the future (i.e. their time components both negative or both positive) must be timelike.

(**Hint:** choose suitable frames.)